

## Quantitative Approaches to Fiscal Sustainability Analysis

### A New World Bank Tool Applied to Turkey<sup>1</sup>

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#### Abstract

Fiscal sustainability analysis (FSA) is an important component of macroeconomic analysis. This paper reviews various quantitative approaches to FSA with a major objective to bring these approaches together and to present a user-friendly tool for FSA that reflects modern developments. We combine a dynamic simulations approach with a simplified version of the steady state consistency approach. We also incorporate two different methods to deal with uncertainty: user-defined stress tests and stochastic simulations. The tool goes further by evaluating the required fiscal adjustment as a consequence of the stochastic realizations of the exogenous variables. Furthermore, the FS tool incorporates an endogenous debt feedback rule for the primary surplus, a fiscal policy reaction function. Besides outlining the theoretical framework, we also present a case study for Turkey.

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<sup>1</sup> This paper is to be used together with the technical instruction manual (WPS 4170), which provides step-by-step technical instructions for running the FSA tool, and includes mathematical appendices and a glossary.

# 1 Introduction

Long-run sustainability has moved to center stage in the analysis of fiscal policy as the emphasis moved away from short-run concerns with smoothing business cycle fluctuations after the spectacular failure of stabilization policies in the West after the 1973 oil crisis. This reorientation has been part of a process of rethinking the role of government, with less emphasis on active involvement and a stronger focus on providing a stable environment for the operation of the private sector. Fiscal Sustainability Analysis (FSA) is now the linchpin of macroeconomic analysis. Unsustainable policies will change, and will be expected to do so, and are thus a natural cause of instability.

FSA has for example become an important element of the design and evaluation of anti-inflation programs. Many of the elements of FSA of course can already be found in the IMF's workhorse for standby programs, the Polak monetary programming model. Also, a long series of balance of payments crises has been linked to a lack of fiscal sustainability, particularly the series of failed stabilization efforts in Latin America in the late 1970s and 1980s. There unsustainable fiscal policies, or the anticipation of policy change because of perceptions of lack of sustainability, triggered the BoP crises that brought several stabilization programs to a crashing halt. And even the Asia crisis in 1998, where the main protagonists had no major visible fiscal imbalances *ex ante*, has by some been linked to off-budget fiscal liabilities related to implicit or explicit bail-out guarantees in the financial sector (Burnside and Rebelo (2001)). FSA has also become an important element of structural reform packages; suggestions of future policy change make it profitable to wait with investment decisions until more information has trickled down (van Wijnbergen, 1986), so the chances of success of reform programs can be seriously impaired by (perceptions of) fiscal unsustainability.

There are thus manifold reasons to assess the consistency of the various policies and measures that are brought together under the heading fiscal policy. Yet in practice approaches are often ad hoc and qualitative. A standardized framework is not yet available, although there has been substantial progress in various directions compared to for example the IMF's monetary programming model, a model that can be interpreted as an attempt at FSA, be it with a short-run focus<sup>2</sup>. A major objective of the current paper and associated software development is to bring

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<sup>2</sup> cf Anand and van Wijnbergen (1988) for a discussion of the link between the Polak model and FSA

these various strands together and present a modern tool for FSA that reflects progress in the field on this topic, links easily with existing datasources, and is user-friendly for the practitioner/country economist.

So what are these “various directions”, in which work has progressed and that will be brought together in the model presented here? An early approach to FSA is presented in Anand and van Wijnbergen (1988,1989) and van Wijnbergen (1989), AW in short. AW, like the Polak model, tightly links inflation, monetary policy and fiscal deficits, an approach that requires consolidation of the Central Bank into the Public Sector Accounts (Anand and van Wijnbergen 1988). But the focus is more on long run consistency between inflation targets and their fiscal impact if achieved, fiscal deficits and debt management policies. The approach taken there to quantify the fiscal impact of inflation is based on the public finance view of inflation associated with Phelps (1973), where inflation is seen as the residual tax. It is a tax because it forces money holders to reduce expenditure below income just to maintain the real level of money holdings constant in the face of high inflation. Hence the concept “inflation tax”. AW pay a great deal of attention to the structure of the financial system as a key determinant of the link between inflation on the one hand and inflation tax “revenues” on the other. The approach is thus particularly well suited to FSA in the context of stabilization efforts, macro-assessment of tax reforms and so on. But there is no serious attention to off-steady state (debt) dynamics and no attention at all to uncertainty.

The IMF’s own efforts (IMF 2005, 2006) have taken a different direction. The Polak model’s integration of CB and public sector more traditionally defined, is abandoned and the focus has shifted towards public debt dynamics. Without integration of the CB seigniorage and inflation tax have to be dropped from the analysis, so the link with anti-inflation programs cannot be made anymore within the new IMF approach, where debt dynamics has moved to the foreground.

Several extensions to the IMF approach have been made recently. Celasun e.a.(2005) introduce uncertainty using simulation methods; the stochastic properties of key variables determining fiscal deficits are used to simulate debt dynamics using monte carlo simulation techniques and so derive the probability distribution of debt stocks at given moments in time in the future. This goes beyond the more ad hoc scenario analysis contained in the official IMF approach (IMF (2005)). Celasun e.a. (2005) also introduce fiscal reaction functions, an important short cut to modeling the dynamic properties of fiscal policy making (for an early strong argument in favor of

this approach in the academic literature see Bohn (1998). At the World Bank the IMF's emphasis on debt dynamics has been combined with AW's integration of public sector and CB accounts to re-introduce seigniorage in the analysis, but without the long-run consistency approach and detailed financial sector modeling characterizing the AW models (see Burnside (2005)).

The approach presented here combines all these strands into a simple template usable for country economists, yet sufficiently rich to reflect the results that have come out the research sketched above. The model follows AW in tightly integrating the CB into the public sector, which allows us to bring seigniorage income and the inflation tax back into the analysis. This will allow analysis of the consistency and sustainability of inflation targets within a given set of fiscal plans, a crucial point given that structural reform packages are often embedded in a macroeconomic stabilization program. But we go beyond the steady state analysis of AW by also introducing debt dynamics, like in IMF (2002, 2003) and Burnside (2005). This first of all allows us to analyze how serious deviations from consistency are, and what the trade off is between adjusting now versus adjusting later, if that buys time, but at the expense of a larger required adjustment.

Possibly even more important is that the explicit introduction of debt dynamics allows us to introduce debt structure and the exposure to risk introduced by the structure of the debt into the analysis. Vulnerability to sudden stops is often related to debt structure, especially if there are high peaks in refinancing needs. This occurs often when a substantial part of the debt is issued at short maturity and/or indexed to foreign exchange. In addition, even if the public sector has its house in order, large private sector imbalances and widening current account deficits may trigger expectations of exchange rate depreciation, especially under pegged or managed float exchange rate regimes. And devaluation leads to large capital losses on foreign currency denominated debt and possibly to pressures to bail out failed banking institutions to avoid a systemic banking crisis. Analysis of these issues requires explicit introduction of the structure and composition of public sector debt.

Moreover, the vulnerability of market access countries to sudden stops and reversals of capital inflows makes it critical to incorporate uncertainty in the analysis of fiscal sustainability. Uncertainty surrounding public debt dynamics is often related to uncertainty about medium term projections of the economic growth rate, the primary balance, the cost of public sector borrowing and the existence of either explicit or implicit guarantees of debt or bank deposits.

We use two different approaches to introducing uncertainty and risk in the analysis. To deal with vulnerability to specific shocks, the template provides a variety of single factor stress tests, as used for example in IMF(2002,2003). However to get a broader view on the riskiness of the basic projections, we also introduce the possibility of a full set of stochastic simulations using the stochastic properties of key variables in the debt dynamics process. While stress tests with respect to individual exogenous variables provide valuable insights to the robustness of the projections with respect to specific shocks, the stochastic simulations approach has the advantage of deriving the distribution of future debt stocks, based on stochastic realizations of key debt determinants, accounting for their variances and covariance structure. This allows a full assessment of the likelihood that the economy lands in dangerous waters. We also use graphical tools to represent the results, i.e. fan charts, like Celasun e.a. (2005). The fiscal sustainability tool goes beyond Celasun e.a. (2005) in presenting not just the distribution of debt output ratios at various moments into the future, but also the (distribution of the) fiscal adjustment necessary to restore consistency and stability to the process. This measure is more useful to policy makers.

Stochastic simulations maybe misleading if they use an assumption of unchanged primary deficits after stochastic shocks while the Government has a record of responding to debt shocks by tightening its belt. We therefore also incorporate **fiscal policy reaction functions**, endogenous debt feedback rules for the primary surplus, as an additional option for stochastic simulations and other stress tests, as suggested in Bohn (1998) and Celasun, Debrun and Ostry (2005). Bohn (1998) shows that the nature of fiscal reaction functions are a key requirement for stability of fiscal programs.

In what follows, section two outlines the analytical framework, section 3 demonstrates the application of the fiscal sustainability tool for the case of Turkey, and the last section presents concluding remarks.

## **2 Analytical Framework**

At the outset, it is important to stress that the fiscal sustainability analysis presented here is not based on a fully-specified macro model. Instead an accounting framework is at the basis of FSA, with the single exception of the fiscal policy reaction function mentioned before. Therefore, the FS template does not provide the government with a tool to optimally set policy variables such

that a particular welfare function is maximized; rather the more modest goal is to assess the sustainability of whatever policy package is chosen.

## 2.1 Solvency and Debt Dynamics

Solvency is not much more than an intertemporal extension of staying within one's means: a government is solvent if it does not intend to spend more than its income plus initial wealth (or minus net debt). The intertemporal equivalent of staying within one's means implies that the discounted value of current and future income plus initial wealth should at least be equal to the discounted value of all current and future non-interest expenditure. Interest expenditure and income is incorporated through the discounting procedure. Formally this comes down to:

$$(1) \quad b_0 + \sum_1^{\infty} \frac{g_i}{(1+r)^i} = \sum_1^{\infty} \frac{t_i + s_i}{(1+r)^i}$$

$$b_0 = \sum_1^{\infty} \frac{ps_i + s_i}{(1+r)^i}$$

(1) states that the discounted value of all non-interest expenditure  $g_i$  plus initial debt  $b_0$  should (at most, but we assume the equality sign in what follows) equal the discounted value of all public sector non-interest income, here summarized as the sum of tax revenues  $t_i$  and seigniorage revenues  $s_i$ . Seigniorage is the net income the public sector (Government and Central Bank, cf Anand and van Wijnbergen (1988) for this point) derives from issuing money. This can be rewritten as the second line from equ. 1.1, initial (net) debt should at most equal the discounted value of the primary or non-interest government surplus  $ps_i$  plus seigniorage  $s_i$ .

To understand the implications and structure of (1), it helps to write down a simpler construct, the so called flow budget constraint:

$$b_t = b_{t-1}(1+r) - (ps_t + s_t)$$

or, equivalently :

$$(2) \quad b_{t-1} = \frac{ps_t + s_t}{1+r} + \frac{b_t}{1+r}$$

(2) states that initial debt plus interest payments plus the primary deficit (or rather minus the primary surplus), and, finally, minus seigniorage revenues, equal the new level of debt. We can

rewrite this as an expression for initial debt, as is done in the second line of equation (2); there we see that initial debt equals the discounted sum of the primary surplus plus seigniorage, and end of period debt. This way of writing the flow budget constraint should also make it clear how discounting takes care of interest payments; if we would include them into the deficit definition, we would essentially count them double. If we substitute (2) repeatedly into itself, for  $t$  starting at 0 and running up to infinity, we get:

$$\begin{aligned}
 (3) \quad b_0 &= \frac{ps_1 + s_1}{1+r} + \frac{b_1}{(1+r)^1} \\
 &= \frac{ps_1 + s_1}{1+r} + \frac{ps_2 + s_2}{(1+r)^2} + \frac{b_2}{(1+r)^2} \\
 &= \lim_{t \rightarrow \infty} \sum_1^t \frac{ps_i + s_i}{(1+r)^i} + \lim_{t \rightarrow \infty} \frac{b_t}{(1+r)^t}
 \end{aligned}$$

Combining (3) with equation (1) shows that solvency requires:

$$(4) \quad \lim_{t \rightarrow \infty} \frac{b_t}{(1+r)^t} = 0$$

Or in words, the debt should ultimately not grow faster than the rate of interest.

This result is behind econometric approaches to testing for solvency. Hamilton and Flavin (1986) use equ. (4) as a starting point for a series of unit root tests to establish compliance of a given time series of debt stocks with equation (4). Passing the unit root test (first for the budget surplus, then for the debt stocks themselves) means that the process, if it continues in conformity with the econometrically recovered structure, will be within solvency limits. Failure does not necessarily mean insolvency, however, since the test will also fail when  $b_t$  converges to a positive number at a rate that is positive but lower than  $r$ . A variant on the HF approach uses regression analysis to see whether coefficients on terms proportional to  $(1+r)^t$  are significant in an equation linking debt to past deficits and past debt stocks (see Burnside (2005) for a survey of research in this area). Like already explained for the HF approach, this second econometric approach also has weak power against near-alternatives.

But there is a bigger problem with econometric approaches, because of which they are not really useful for policy analysts looking at the stability of reformed budget processes, as is typically the case when FSA is performed as part of a package of structural reform measures. The reason is that both approaches are backward looking, and can by construction not say anything about reformed policies without track record. Before switching to alternative, forward-looking methods of FSA, a final word on the concept of liquidity.

Liquidity refers to government's ability to roll-over its maturing liabilities and finance current deficits by using its liquid assets and access to new financing. Suspicions of insolvency can certainly lead to liquidity problems, but liquidity problems can be triggered by other factors too. An example is *contagion* from crises in other countries, without any fundamental reason within the country itself. Another example are situations of Debt Overhang, where access to new finance is blocked even in the presence of profitable investment opportunities because too much of new revenue will be diverted towards the servicing of old arrears, i.e. when old debt has equity characteristics (get paid in good times only). Vulnerability to such problems is related to structure of debt (when debt is skewed towards short-term debt and/or debt indexed to FX). However, in practice it is often hard to make a clear distinction between solvency and liquidity.

## 2.2 *Forward Looking Approaches: Dynamic Simulations*

Because of the problems with backward looking approaches we take a forward looking, dynamic simulations approach. The first step in such an approach is to create a baseline scenario of the likely future time path of the public debt-to-GDP ratio, using the flow budget constraint equation. (2). This baseline uses the flow budget equation to update future debt stocks based on macroeconomic projections of key determinants of public debt dynamics, such as growth, inflation, projected primary surpluses and interest rates.

Before going into the details one important point. To insure consistency between debt stocks, deficits and revenue from seigniorage, it is necessary to consolidate the general government accounts with the Central bank's profit and loss account (see Anand and van Wijnbergen (1988)). Otherwise seigniorage, an important source of revenue in most countries outside the OECD, will not show up in the budget dynamics, and debt maybe mis-measured by failing to take into account assets held by the Central Bank.<sup>3</sup> Public sector foreign debt is then measured net of the (net)

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<sup>3</sup> For detailed derivations and analysis see Anand and van Wijnbergen (1988).



foreign asset holdings of the Central Bank, and public sector domestic debt net of holdings of such debt by the same Central Bank. Similarly, deficits and the ensuing liabilities for the state may be seriously mis-measured if the quasi-fiscal deficit of the Central Bank is excluded. This is a major shortcoming of the recent IMF approach to sustainability (IMF 2002,2003)).

After that consolidation, increases in net public debt (i.e. measured net of the net foreign asset and public debt holdings of the central bank) can be decomposed in various contributing factors, which in turn can be linked to the macroeconomic projections available. Switching to ratios to GDP and indicating that by a tilde above the relevant variables, public debt dynamics can be broken down in several components: (A) the primary fiscal deficit net of seigniorage revenues, (B) growth adjusted real interest rate payments on domestic debt; and (C) the real cost of external borrowing, including capital gains and losses on net external debt due to changes in the real exchange rate. In formulas:<sup>4</sup>

$$(5) \tilde{d} = (\tilde{pd} - \tilde{s}) + (r - g)\tilde{b} + (r^* + \hat{e} - g)(\tilde{b}^* - \tilde{nfa}^*)e + OF$$

where  $\tilde{d}_t$  is the net public debt-to-GDP ratio,  $\tilde{pd}_t$  is the primary deficit as a share of GDP,  $g$  is the real GDP growth rate,  $r$  is the real interest rate on domestic debt,  $r^*$  is the real interest rate on external debt and  $e$  is the real exchange rate,  $\frac{EP^*}{P}$  with obvious definitions of variables.

Equation (5) separates the different factors contributing to the evolution of public debt to GDP ratio: (i) the primary fiscal balance; (ii) the revenue from seigniorage; and (iii) automatic debt dynamics, which includes factors such as the real GDP growth; the real interest rate on domestic and external debt and the real exchange rate. It also includes a catch all term, O(ther) F(actors). OF collects residuals due to cross product terms arising because of the use of discrete time data (see Annex A.1 in Bandiera e.a. (2006) for an elaboration) and the impact of debt increasing factors that in a perfect accounting world would be included in deficit measures, but in the real world are not. Examples are contingent liabilities that actually materialize, such as the fiscal consequences of a bank bail out, one-off privatization revenues, and so on. Of course if countries borrow in more than one foreign currency (e.g. dollars and Euros, or Yen), more than one foreign debt stock should be kept track of in analogous manner.

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<sup>4</sup> Note that to simplify the exposition we present a continuous time formula. However, as shown in the Annex, in the FS template we use the discrete time formulas for deriving the public debt dynamics.

### 2.3 *Steady State Consistency Approach and the Required Deficit Reduction Measure*

A major disadvantage of the debt simulation approach is that it does not give very precise indications to policymakers on what to do and by how much adjustment is required. It indicates whether budgetary processes lead to unsustainable growth within the macro environment assumed; but it does not indicate by how much various instruments and targets need to change to restore stability. We therefore introduce a second indicator, the required deficit reduction measure  $rdr$  that gives precisely that information.<sup>5</sup> The  $rdr$  indicator equals the deficit reduction necessary to restore consistency between various macroeconomic projections on growth and interest rates, inflation targets on the one hand, and the requirement of a stable debt/output ratio on the other.

Inconsistency between fiscal policy and monetary targets has played a major role in the long history of stabilization failures. If monetary targets aim for an inflation rate below what is needed to close the government's financing gap given debt policy, interest rates and primary deficits, monetary policy is inherently incredible and may in the end actually lead to higher instead of lower inflation. The consistency approach, developed by Anand and van Wijnbergen (1988), links inflation, fiscal deficits and public debt management and is designed to enhance the understanding of fiscal policy, its interactions with other macroeconomic policies, and the constraints faced by policy makers. This approach is also implemented here.

In the model the primary deficit is taken to be a policy parameter (an exception is the introduction of the fiscal policy reaction function discussed below in the Section on stochastic simulations). Base money growth, for any given inflation target, is endogenously determined from the demand side by the path of the real interest rate, the financial structure and the growth rate. The  $rdr$  measure gives the adjustment necessary in the primary deficit to make sure that given inflation (money growth) targets is consistent with on the one hand the other policy parameters and structural characteristics of the economy, and on the other the requirement of a stable debt-output ratio:

$$(6) \quad \tilde{rdr} = [\tilde{d} + r.\tilde{b} + (r^* + \hat{e})(\tilde{b}^* - n\tilde{f}a^*)e] - [g.\tilde{b} + g(\tilde{b}^* - n\tilde{f}a^*)e + (g + \pi)\tilde{m}]$$

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<sup>5</sup> For an extensive discussion of this measure cf Anand and van Wijnbergen (1988, 1989)

The first term between square brackets on the right hand side of (6) stands for the actual public sector deficit and includes real interest payments on domestic and (net) foreign debt. The second term represents the financeable deficit. This measure restricts borrowing by the constraint that domestic and foreign debt should not grow faster than output, and adds to that borrowing capacity the resources collected through the increase in the monetary base, i.e. seigniorage, that is consistent with the various macroeconomic targets and stable money-output ratios.

Seigniorage  $(g+\pi)m$  equals the real value of the nominal increase in base money,  $\Delta M/(PY)$ , where  $\pi$  equals the target inflation rate. The first term,  $g.m$ , equals the increase in real balances that people are willing to hold simply to keep the money-output ratio constant in the face of growth  $g$ . The second term,  $\tilde{\pi}m$ , equals the increase in nominal money balances necessary to keep the real value of money constant given inflation  $\tilde{\pi}$ . Of course the relation between demand for base money and inflation depends among others on financial structure and regulation (e.g. reserve requirements) and as such is for example likely to change in the aftermath of financial sector reform; cf Anand and van Wijnbergen (1988) for an extensive discussion. However, given the lack of longer time series data for a number of developing countries, and the requirement to make a generally usable template for FSA, the fiscal sustainability tool simplifies the estimation of the revenue from seigniorage by using a simple Cagan money demand function. The only additional requirement then is to estimate the coefficient of the elasticity of money demand with respect to nominal interest rate (or inflation), which represents the opportunity cost of holding money. A default value of 0,33 is assumed for the semi-elasticity, a number that has general empirical support. The estimated coefficient (or, in the absence of estimation results, its default value) will be used to determine the amount of seigniorage to be expected given the assumed inflation targets. We also show the maximum amount of seigniorage revenue that the government can get from printing money, as well as the seigniorage maximizing rate of inflation.

## 2.4 *Incorporating Uncertainty*

So far, we have in line with most of the literature surveyed, assumed deterministic paths for the underlying variables. That is clearly a serious shortcoming; there is little doubt that all input projections are surrounded with a great deal of uncertainty, and so are, therefore, the results of any deterministic analysis. Uncertainty leads to two separate questions, requiring separate approaches

for their answer. First, given that there is uncertainty attached to projections of variables such as interest and growth rates, exchange rate developments and so on, how sensitive are the results to a given shock in any of the variables used as input in the exercise? Second, again given the uncertainty surrounding almost all variables, how much confidence can we have in the outcome of the base run?

We deal with the first question by introducing *stress tests* dealing with specific risks (in the next section). To get an answer to the second question, we resort to full scale *stochastic simulation methods*, using data about the actual probability distribution of the input variables (cf 2.4.B-C)..

#### *A Incorporating User-Defined Stress Tests*

One can get a feeling for the sensitivity of the results with respect to specific shocks by conducting a set of sensitivity tests to the baseline scenario, assuming that the underlying variables swing away from their means by one or two standard deviations. This approach ignores the endogenous interactions between input variables, and as such is not a substitute for a full macro model based analysis. But the merit is that this approach significantly reduces the computational complexity and data requirements, and still gives meaningful insights in the sensitivity of the model results to exogenous shocks. The most important sensitivity analyses include stress tests with respect to real interest rates on public domestic and foreign currency debt, real output growth, primary balance, and changes of the real exchange rate.

### **Box 1. Standardized sensitivity tests**

#### *Alternative Scenarios*

- A1. Historical average scenario, where all variables are set equal to their historical averages in the projections.
- A2. No-Policy-Change, where the primary balance is assumed to remain constant at its actual value for the whole projection period.
- A3. Country-specific shock that would lead to a permanent one-standard deviation decline in real growth rate.
- A4. Market forecast scenario, where all variables are set equal to their market/consensus forecasts.
- A5. Oil Prices are set equal to WEO/DECPG projections -  $1\sigma$  (relevant for oil-rich countries template)

#### *Bound Tests*

- B1. Real interest rate = historical mean +  $2\sigma$  for the first two years of projections
- B2. Real GDP growth rate = historical mean -  $2\sigma$  for the first two years of projections
- B3. Primary balance = historical mean -  $2\sigma$  for the first two years of projections
- B4. Real exchange rate based on one year nominal appreciation of 30 percent.
- B5. One-time realization of contingent liabilities
- B6. Oil price shock = WEO/DECPG projections -  $2\sigma$  for oil-rich countries template
- B7. A Combined one-standard deviation shock of all variables relative to their historical mean for the first two years of projections.

*Source: IMF(2003).*

The purpose of the various alternative scenarios is to facilitate discussion of key vulnerabilities of the economy and to ensure more realistic fiscal sustainability assessments.

For example, to check the realism of the baseline policy projections, it is useful to run an alternative scenario, where all variables determining debt dynamics are set equal to their long run historical averages. Furthermore, to account for country specific sources of vulnerability, the fiscal sustainability tool also allows for a specific crisis scenario, to be set up by the user.

The fiscal sustainability tool can be also used to assess the impact of reforms embedded in the medium term projection framework in the base case, by running a counterfactual scenario where the primary balance remains unchanged during the projection period as compared to its actual level during the current year. Finally, the tool can also use market information, whereby financial variables (exchange and interest rates) are set equal to their forward or futures values, while consensus forecasts could be used for variables such as growth and inflation.

The set of bound tests, on the other hand, provide a probabilistic upper bound for the debt dynamics under various assumptions on macroeconomic developments, borrowing costs and policy variables. The bound tests include real interest rate shock, real output shock, primary balance shock, exchange rate shock, a realization of contingent liabilities, and a combined shocks to all variables (see Box 1).<sup>6</sup> However, some caution is required when interpreting these stress tests, as they do not capture the relationships among the key debt determinants.

## *B Stochastic Simulations*

An alternative to stress tests is full scale Monte Carlo simulation (cf IMF (2003) and Celasun, Debrun and Ostry (2005)). Using estimated parameters of the joint distribution of all input variables, the distribution of these variables can be simulated jointly using Monte Carlo methods. In practice that means that for  $n$  input variables and a horizon of  $T$  years,  $n$  random numbers are simulated  $T$  times, transformed using the VAR estimation results in such a way that the resulting distribution conforms to the VAR estimates of the true distribution of the input variables (cf FSA Technical Manual, Bandieri e.a. (2006)). This is done repeatedly until the generated and empirical distribution are sufficiently close (by default 5000 runs are generated). And for each run, the model is applied to derive the full path of debt stocks and values of the required deficit reduction measure  $rdr$ . In this way the full probability distribution of debt/output ratios and the  $rdr$  measure at each future point in time is derived. The probability density of the outcomes of debt ratio and of the  $rdr$  measure of necessary fiscal adjustment in each year can be plotted from the stochastic simulations, generating a so called “fan chart” for debt-to-GDP ratio and the  $rdr$  variable.

A difficulty for many countries may be that estimating a VAR model requires long time series for key debt determinants; this maybe a problem for a number of developing countries either due to data availability or to structural breaks. To remedy these problems we also provide options to simplify the stochastic simulations. We also allow for the possibility to construct stochastic simulations using only the variances of the four random variables that are key debt determinants, ignoring any covariance that may exist between them. In this case, the tool uses as (over-writeable)

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<sup>6</sup> As pointed out in the IMF(2003), these tests come close to a 95-99 percent confidence interval around the projected evolution of public debt ratio, conditional on a debt crisis occurring.

default value the average of base line projections/assumptions of these four key determinants over the projection period as an estimate of the mean, and the historically computed variance as an estimate of the variance of the distribution of each of these random variables.

### *C      Fiscal Reaction Functions*

Bohn (1998) shows that, if all other determinants of fiscal policy are stationary, a positive correlation between the primary surplus and the past level of the public debt-to-GDP ratio is sufficient to guarantee fiscal sustainability. But standard user-defined stress tests as in the IMF (2002, 2003) or in our discussion so far usually treat primary balance as a variable independent of other underlying variables. Since the government may take deliberate corrective actions as its debt stock rises, these stress tests may overestimate the impact of shocks in the user-defined stress-tests.<sup>7</sup> The fiscal sustainability template therefore also provides the option to introduce a fiscal policy reaction function, available in both the pre-defined stress tests and the stochastic simulations.<sup>8</sup>

Specifically, the fiscal policy reaction function can be estimated using a historical data, linking the primary balance to the stock of debt in the previous period, business cycles, and random shocks. The resulting feedback parameter (“alpha”) from debt to primary deficit can be used in the template. If data availability and/or structural breaks prevent actual estimation, the user can supply a value for alpha, which typically is of the order of magnitude of the real rate of interest (expressed as a fraction).

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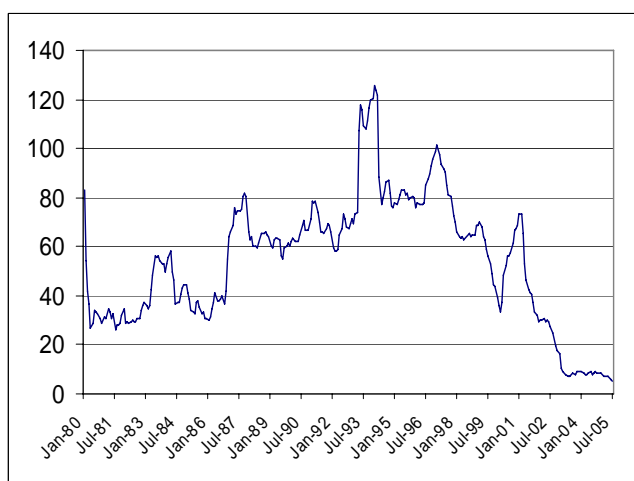
<sup>7</sup> Bohn (1998) illustrates the behavior of U.S. primary balance in response to increases in the public debt-to-GDP ratio.

<sup>8</sup> See Celasun, Debrun and Ostry (2005) for a similar approach.

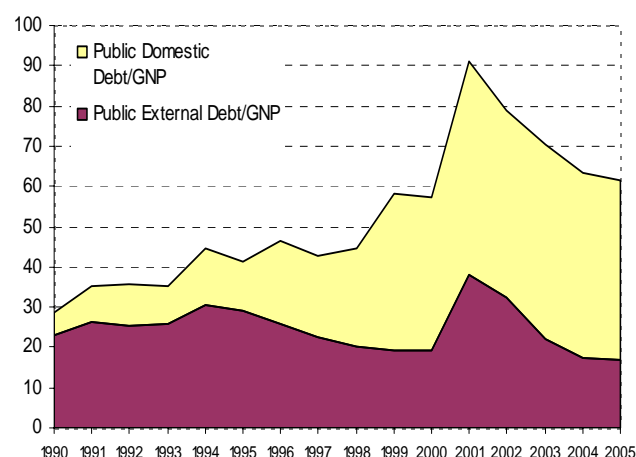
### 3 Fiscal Deficits, Inflation and Sustainability of Public Debt in Turkey

Throughout 1980s and 1990s, there have been many attempts to stabilize inflation in Turkey, but all of the failed until the recent successes changed the pattern. After each failed attempt, inflation in the end settled at a rate higher than prevailed before the stabilization attempt was initiated. Similarly, net public debt-to-GNP ratio has been steadily increasing in 1990s, and doubled in 1999, compared to its level in 1990 (less than 30 percent). After a small decline in 2000, the debt ratio increased by nearly 40 percent, reaching 91 percent in 2001, or more than three times its 1990 level.

**Figure 1.a. Rate of inflation (80- 05)**



**b. Public debt to GDP ratio (1990-2005)**



*Note: Rate of change of the CPI index 12 month ahead. IMF projections were used to calculate the 12 month ahead inflation after 2004/8.*

But the devastating financial crisis in 2001 seems to have triggered a break in the cycle of high inflation, failed stabilization attempts, rising debt burden and higher inflation. Following the 2001 financial crisis, Turkey has adopted economic reforms to address the underlying economic vulnerabilities, regain macroeconomic stability, and to signal a clear break with the past.

Key elements of these reforms were maintaining a floating exchange rate, government's commitment to high and sustained primary fiscal surpluses, bank recapitalization and restructuring to reduce quasi-fiscal activities, as well as other structural reforms, ranging from privatization to governance reform. As a result of these reforms, and driven mainly by revenue increases, the average primary fiscal surplus during the past four years was increased to nearly 6 percent of GDP.



The large adjustment in the primary deficit (turning it in a substantial surplus) has reduced the overall fiscal deficit substantially, and more than one-for-one, as improved credibility led to lower interest rates.

As a result, Turkey has witnessed a dramatic reduction in inflation since 2001 – the annual average inflation rate has actually fallen to single digit levels in 2004, and has declined even further in 2005. Strong capital inflows and the large fiscal adjustment allowed the Central Bank of Turkey (CBT) to cut the policy interest rates as inflation declined rapidly. Similarly public debt burden was reduced substantially as the net public debt ratio declined to 61.2 percent of GDP by end-2005 compared to its peak of 89.5 percent during the 2001 financial crisis. The composition of public debt also improved considerably since then, with the share of foreign-currency denominated debt falling from 40 to 28 percent of total public debt. Large fiscal adjustment, robust economic growth and strong real exchange rate appreciation has contributed substantially to this debt reduction process.

Is the current situation, with inflation at a single digit level for the first time since decades sustainable? Can Turkey grow out of its debt problem, lowering further its debt burden to more manageable levels and is Turkey still vulnerable to sudden reversal of capital inflows?

To answer these questions, this section uses a forward-looking fiscal sustainability approach, which is implemented in the FSA tool and applies it for the case of Turkey.<sup>9</sup> Many issues that are familiar from other countries appear here, making the case of wider interest than only a specific case. First, we use public debt dynamics to create a baseline projection of future trends in public debt to GDP ratio, utilizing existing macroeconomic projections. Second, to check the realism of the baseline scenario, we conduct sensitivity tests. Third, to assess the consistency of the fiscal strategy with the targeted inflation rate, stable debt ratios, and with other structural characteristics of the economy, we apply a simplified version of the steady state consistency framework of AW (1989) and we also check the sensitivity of the  $rdr$ , the consistency measure, using stress tests. Finally, to depict the magnitude of upside and downside risks surrounding public debt projections and the  $rdr$  (the consistency) measure, we use stochastic simulations approach. Finally, we also check the implications of allowing for fiscal policy reaction functions – or for a positive debt feedback rules.

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<sup>9</sup> For more detailed information on this tool, see Bandiera, Budina, Klein and van Wijnbergen (2006).

### 3.1 Baseline Scenario for Public Debt Dynamics

In what follows we use the FS tool to develop a baseline scenario for public debt dynamics over the projection period. The derivation of public debt dynamics is based on a debt updating equation (see eq. 5, section 2 for the continuous time version)<sup>10</sup>. Key inputs used to derive public debt dynamics are taken from macroeconomic projection framework.<sup>11</sup> As discussed in section 2, implicit in this approach is the proper consolidation of the general government accounts with the Central bank's profit and loss account.<sup>12</sup> Public debt-to-GDP ratio can change as a result of primary deficits,  $pd$ , net of seigniorage revenues,  $\sigma$ ; "automatic debt dynamics" (the difference between real interest and real growth rates), and changes in the real exchange rate,  $e\text{-}hat$ , resulting in capital gains or losses on net foreign-currency denominated debt. Baseline projections of these debt determinants are summarized in Table 1:

Table 1. Key Macroeconomic and Fiscal Assumptions

	<u>Actual</u>			<u>Projections</u>			
	2005	2006	2007	2008	2009	2010	2011
Real GDP growth (in percent)	4.8	5.0	5.0	5.0	5.0	5.0	5.0
Average real interest rate on foreign debt in percent	7.6	8.0	8.4	8.4	8.4	8.4	8.4
Average real interest rate on domestic debt in percent	11.7	5.3	10.2	11.2	11.1	11.1	11.1
Change in the real exchange rate (Local currency per US dollar)	5.1	-1.0	-0.5	-0.4	-0.8	-0.8	-1.0
Inflation rate (in percent)	6.8	6.0	4.5	3.5	3.5	3.5	3.5
Primary deficit, percent of GDP	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5

Source: World Bank and IMF staff estimates

To derive public debt dynamics for the consolidated public sector, the FS tool also provides an estimate of the revenue from seigniorage during the projection period. Key inputs in the calculations of seigniorage revenue are projections for average inflation rate, average price level

<sup>10</sup> Note that we use continuous time formulas for the easiness of exposition. The FS tool, however, uses the discrete time version of the debt updating equation. For the exact discrete time formulas see the Technical instruction manual that accompanies this paper.

<sup>11</sup> See the technical instructions manual, section III.

<sup>12</sup> For detailed derivation and exposition see Anand and van Wijnbergen (1988).

and real GDP (Table 2). The tool uses Cagan money demand function to estimate base money as a function of expected inflation.<sup>13</sup> This tool also assumes a default value for the semi-elasticity of money demand with respect to inflation, 0.3, consistent with previous findings of seigniorage maximizing rate of inflation of around 300 percent for Turkey.<sup>14</sup> Based on these assumptions, seigniorage revenue is projected at about 0.6 percent of GDP on average during the projection period.

*Table 2 Benchmarking Revenue from Seigniorage*

	<i>Base year</i>	<i>Projection Period</i>					
	2005	2006	2007	2008	2009	2010	2011
Real GDP growth, percent	4.8	5.0	5.0	5.0	5.0	5.0	5.0
Inflation rate, percent	6.8	6.0	4.5	3.5	3.5	3.5	3.5
Base money, percent of GDP	6.11	6.05	6.01	6.01	6.01	6.01	6.01
Seigniorage revenue, percent of GDP		0.71	0.63	0.61	0.61	0.61	0.61

The base case scenario for public debt dynamics assumes continued commitment to maintain high primary fiscal surpluses (6.5 percent of GDP) over the projection period. The CPI inflation is expected to decline further, consistent with the inflation target of 3.5 percent per year. The real interest rates on domestic and external public debt are projected to stabilize at about 10 and 8 percent per year, respectively. The real exchange rate is also assumed to remain broadly stable, appreciating by less than one percent per year. Following the strong growth performance in 2002-2004, growth rates are expected to stabilize at 5 percent, considered the potential growth rate. As a result, in this baseline scenario, the net public debt-to-GDP ratio will continue to decline, falling below 60 percent in 2006, further below 50 percent in 2008 and reaching 29 percent in 2011 (Figure 2a and b).

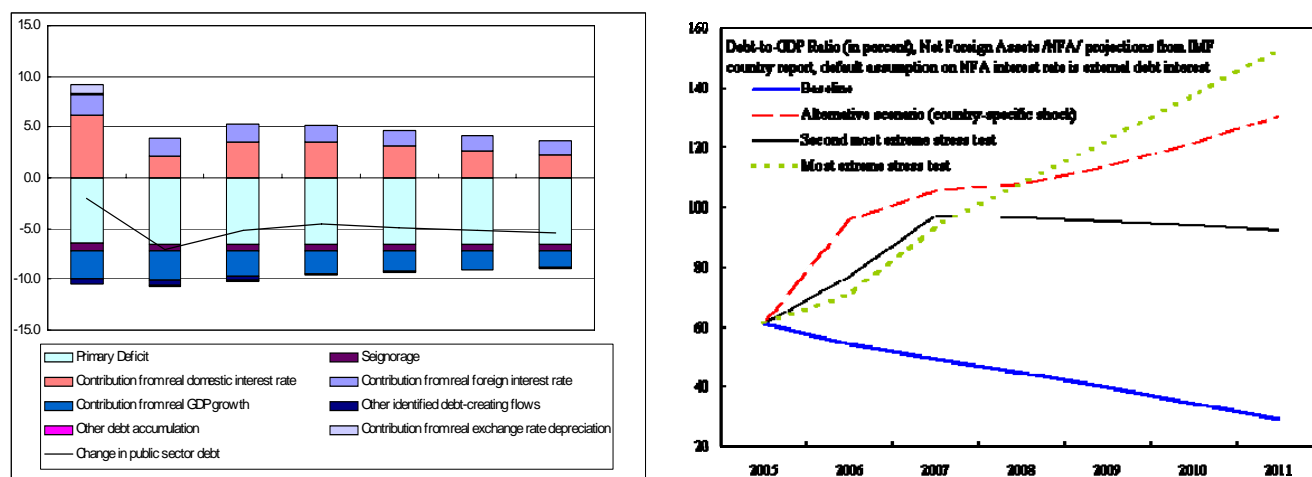
Fiscal adjustment and strong growth will gain additional importance in debt reduction. Based on the projected debt-to-GDP ratios and macroeconomic scenario, the composition of the change in these ratios for 2006-11 indicates the contribution of fiscal adjustment (primary surplus) amounts to about 2/3 of all debt reducing items, while continuing healthy growth also plays a

<sup>13</sup> See the accompanying technical instruction manual, section IV, World Bank WP No.4170.

<sup>14</sup> Note that this is consistent with previous findings of seigniorage maximizing rate of inflation,  $1/\eta$ , of around 300 percent for Turkey. For more detailed financial sector model, please see Anand and van Wijnbergen (1989).

significant role. On the contrary, in the medium term, the expectation is that inflation and seigniorage impact dies off as Turkey succeeds to stabilize inflation at low single digits (Figure 2a).

**Figure 2 a) Public Debt Decomposition in the Base line and b) A Summary of Stress tests**



While the baseline scenario looks rather optimistic, past history shows that key determinants of public debt dynamics are highly volatile and subject to external shocks. The baseline scenario is particularly vulnerable to negative shocks to cost of borrowing, resulting from sudden reversal of capital flows. In addition, even if the public sector has its house in order, large private sector imbalance and widening current account deficit may trigger expectations of exchange rate depreciation with a profound impact on public debt dynamics both in terms of capital losses on foreign currency denominated debt, but also in terms of increasing banking system vulnerabilities, resulting from higher credit risks and/or currency mismatches. To this end, policy recommendations should also account for the impact of various shocks to the baseline scenario.

### 3.2. *An application of stress tests: on the credibility of the baseline scenario*

The FS tool tests the credibility of baseline projections with alternative scenarios and bound tests, which are used to assess the behavior of the public debt ratio in the event of temporary shocks on key parameters. An economic recession, resulting in a 7 percent drop in the real GDP during the first two years of projections is the most extreme stress test in the medium term. Debt dynamics worsens dramatically, and the projected net debt reaches 153 percent of GDP by 2011.

The second most extreme stress test is represented by the country specific alternative scenario, whereby the public debt ratio is projected to increase to 110 percent of GDP by 2011. The results of the sensitivity analysis of public debt dynamics highlight the central role of credible policies that deepen fiscal adjustment in building confidence. As results from these tests indicate (see Table 3), the base case scenario is rather optimistic and there are a number of risks to the debt dynamics.

*Table 3 Debt Sustainability in Standard Bound Tests (% of GDP)*

	2006	2007	2008	2009	2010	2011
<b>Baseline</b>	<b>54</b>	<b>49</b>	<b>44</b>	<b>40</b>	<b>34</b>	<b>29</b>
<b>Alternative scenarios</b>						
A1. Key variables are at their historical averages in 2005-09	<b>60</b>	<b>59</b>	<b>59</b>	<b>58</b>	<b>57</b>	<b>55</b>
A2. No policy change (constant primary balance) in 2005-09	<b>54</b>	<b>67</b>	<b>63</b>	<b>59</b>	<b>55</b>	<b>51</b>
A3. Country-specific shock in 2005, with reduction in GDP growth (relative to baseline) of one standard deviation	<b>96</b>	<b>105</b>	<b>108</b>	<b>113</b>	<b>121</b>	<b>130</b>
<b>Bound tests</b>						
B1. Real interest rate is at historical average plus two standard deviations in 2005 and 2006	<b>76</b>	<b>97</b>	<b>94</b>	<b>92</b>	<b>89</b>	<b>85</b>
B2. Real GDP growth is at historical average minus two standard deviations in 2005 and 2006	<b>71</b>	<b>94</b>	<b>108</b>	<b>122</b>	<b>137</b>	<b>153</b>
B3. Primary balance is at historical average minus two standard deviations in 2005 and 2006	<b>60</b>	<b>61</b>	<b>57</b>	<b>53</b>	<b>48</b>	<b>43</b>
B4. Combination of 1-3 using one standard deviation shocks	<b>77</b>	<b>97</b>	<b>96</b>	<b>95</b>	<b>94</b>	<b>92</b>
B5. One time 30 percent real depreciation in 2005	<b>63</b>	<b>59</b>	<b>55</b>	<b>50</b>	<b>46</b>	<b>41</b>
B6. 10 percent of GDP increase in other debt-creating flows in 2005	<b>64</b>	<b>59</b>	<b>55</b>	<b>51</b>	<b>46</b>	<b>41</b>

The no-policy change scenario, (A2 in table 3), which assumes that primary balance to GDP ratio would remain at its actual 2005, will be identical with the base case, which already assumes a constant primary balance to GDP ratio of 6.5 percent.

The historical scenario, (A1 in table 3) assumes that all variables are set equal to their 10-year historical averages<sup>15</sup>: real output growth is now lower, set at 4 percent per annum as compared with the baseline growth of 5 percent; fiscal surplus is also smaller, 6 percent of GDP, compared with 6.5 percent under the base case, while the real interest rate on domestic debt is much higher, 19.3 percent, compared with about 10-11 percent in the baseline scenario. Table 4 lists all the assumptions under the historical scenario. The resulting debt dynamics is much less favorable, as public debt to GDP ratio will decline only marginally, from 60 to 55 percent of GDP by the end of the projection period (See Table 3).

*Table 4. Key assumptions for Historical Scenario*

	2006	2007	2008	2009	2010	2011
<b>Historical</b>						
Real GDP growth (in percent)	4.0	4.0	4.0	4.0	4.0	4.0
Average real interest rate (nominal rate minus change in domestic CPI, percent)	19.3	19.3	19.3	19.3	19.3	19.3
Average real interest rate on foreign debt (nominal rate minus change in U.S. CPI, percent)	6.0	6.0	6.0	6.0	6.0	6.0
Change in the real exchange rate (Local currency per US dollar)	-1.0	-0.5	-0.4	-0.8	-0.8	-1.0
Inflation rate (GDP deflator, in percent)	6.0	4.5	3.5	3.5	3.5	3.5
Primary deficit, percent of GDP	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0

The country-specific shock scenario, (A3 in table 3), models the impact of country-specific vulnerabilities and risks to the economic outlook. Despite recent improvements, the level and structure of the public debt leave the country vulnerable to a potential loss of market confidence. To model this vulnerability, the country specific alternative scenario was formulated (see table 5 for key macroeconomic assumptions underpinning this scenario). This scenario assumes weakening fiscal efforts leading to lower primary surplus, assumed 3 percent of GDP during 2007-2011. Weaker fiscal efforts will again trigger a loss of market confidence, exchange rate instability and therefore, a worsening debt dynamics. In this scenario, a loss of market confidence is simulated through a sudden stop in the availability of foreign financing, assuming no new disbursements in 2006. This means that all the interest and principal on external debt falling due

<sup>15</sup> See the Technical Instructions Manual, section VI.

has to be repaid, or the government would have to issue new domestic debt not only to finance its deficit, but also to pay back its external debt falling due.

*Table 5. Key assumptions for Country-Specific Scenario*

<b>Country Specific Shock</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
Real GDP growth (in percent)	-6.0	3.0	3.0	3.0	3.0	3.0
Average real domestic interest rate (nominal rate minus change in CPI, percent)	40.0	20.0	15.0	15.0	15.0	15.0
Average real interest rate on foreign debt in percent	10.0	10.0	8.4	8.4	8.4	8.4
Change in the real exchange rate (Local currency per US dollar)	30.0	15.0	-14.2	-6.6	-2.2	-1.0
Inflation rate (in percent)	40.0	30.0	20.0	10.0	5.0	3.5
Primary deficit, percent of GDP	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0

Initially exchange rate will overshoot, leading to a substantial real depreciation, assumed 30 and 15 percent in 2006 and in 2007, respectively. The real exchange rate depreciation will put pressure on domestic real interest rate, which will increase to 40 and 20 percent in 2006 and in 2007, respectively. Similarly, the loss of market confidence will be reflected by a higher default premium, which will be reflected in the increased external cost of borrowing, assumed to peak at 10 percent in 2006 and 2007. As a result, the economy is assumed to contract by 6 percent in 2006 and then recover, but at a much slower pace. Finally, sizeable depreciation is also assumed to create pressures in the banking system, adding up some 15 percent of GDP as recognition of contingent liabilities to public debt.

A reversal in the strong growth pattern and deterioration in the public debt dynamics could lead to renewed capital account outflows, a loss of confidence by foreign investors and exchange rate instability, which would exacerbate the impact on the debt burden. However, as real exchange rate depreciates, growth will recover and will stabilize at 3 percent per year by the end of the projection period. Capital markets are assumed to re-open the access of Turkey to external funds after 2006. As a result real interest rate on external debt is assumed to stabilize at about 8 percent per annum, its base case level. The real interest rate on domestic debt, however, is assumed to decline gradually to 15 percent, higher than in the base case, as a result of a much weaker fiscal adjustment and growth prospects.

Under this scenario, net public debt is projected to increase to 130 percent of GDP (See Table 3). Compared to bound tests, the country specific scenario models the increase in the overall borrowing costs that results from an environment of higher inflation and exchange rate volatility, higher financing requirements and associated weak credibility. However, the magnitude of the assumed shock on real growth rate is still lower than in the bound test on real GDP growth, as the economic crisis and the sudden stop in foreign financing is followed by an economic rebound resulting from an improved competitiveness and re-opening of the capital markets.

### 3.3. *Steady State Consistency between Fiscal and Monetary Policy*

A key feature of credible disinflation programs is internal consistency. Are inflation targets, the associated seigniorage revenues and the primary surplus compatible with stable debt-output ratios? If ever rising debt ratios are the result of the parameters of the program, a clear signal is given that policy change is unavoidable. If fiscal adjustment is postponed, the risk arises that inflation will then be the residual tax, meeting the budget constraint through inflationary erosion of debt and money holdings. If even that mechanism cannot close the gap, for example because of the short maturity or extensive level of indexation of the public debt, actual default becomes a real possibility; with corresponding impact on the risk premia the government can expect to have to pay if any further debt is to be issued successfully.

This section is using a simplified version of the steady state consistency framework of Anand and van Wijnbergen (1989), also available in the FS tool.<sup>16</sup> In particular, this framework links inflation, fiscal deficits and public debt management and aims at enhancing the understanding of fiscal policy, its interactions with other macroeconomic policies, and key constraints to policy makers.

A central aim of this framework is to derive a measure of medium term consistency between fiscal and monetary policy, the required deficit reduction, representing the difference between funding requirements and funding sources, which is needed to stabilize debt-output ratio at the end of the projection period. Note that the required deficit reduction, our fiscal consistency measure, will also change under various alternative scenarios and stress tests. This measure could then be used to indicate whether any given inflation target (money growth) is consistent with a

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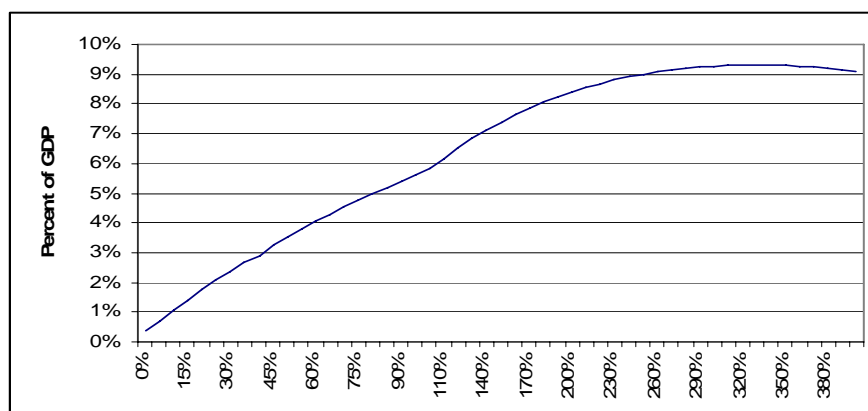
<sup>16</sup> For details on this approach see section 2.3 and The technical instruction manual, section IV.



particular fiscal policy, stable debt ratios and other structural characteristics of the economy – for example, a non-positive value of  $rdr$  would suggest that such a consistency would be in place; alternatively consistency can be imposed which yields the inflation rate which is consistent with a particular fiscal policy target, stable debt ratios and other structural characteristics of the economy – or the inflation rate for which the value of the  $rdr$  measure becomes zero. If the  $rdr$  remains positive for any given inflation rate, this would mean that fiscal policies are not consistent with stable debt ratios, given the key macroeconomic assumptions, which is a clear signal for problems with fiscal sustainability

First, we use a simplified seigniorage model to establish the link between inflation, seigniorage revenue, and the fiscal consistency measure, required to stabilize debt to output ratio at the end of the projection period. Given the steady state assumptions about the real output growth rate of 5 percent and inflation rate of 3.5 percent, and once again assuming a Cagan money demand function, seigniorage revenue is estimated as a function of inflation rate (see Figure 3).

*Figure 3 Seigniorage Revenues and Inflation in Turkey.*



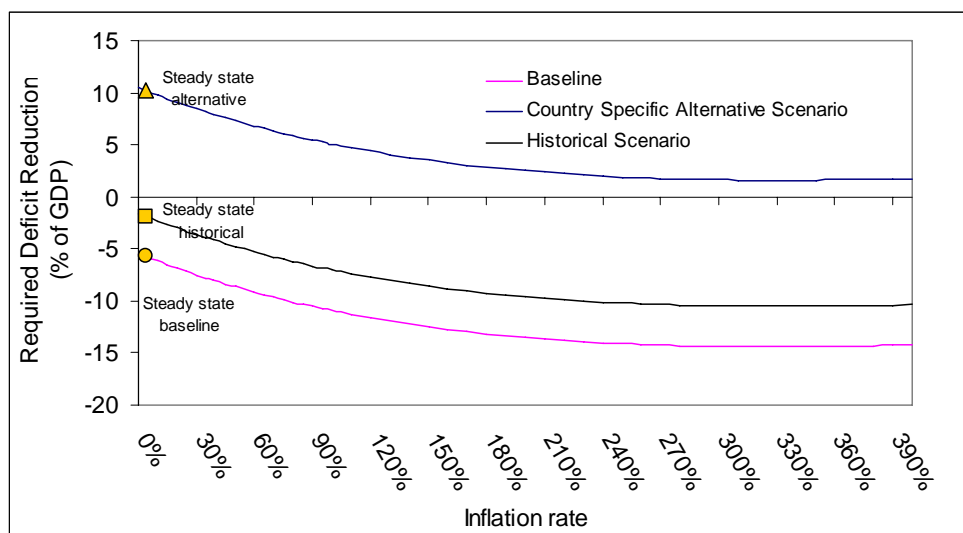
As expected, seigniorage revenue exhibits a Laffer curve property – given the relatively low elasticity of money demand with respect to inflation, the implication is that inflation tax in Turkey could be rather large at high inflation rates.

Then, the FS tool calculates the  $rdr$ , the fiscal consistency measure, for the base case, historical and country-specific alternative scenario, using the last year of the projection period as a base year for the application of the steady state consistency approach. The FS tool also plots the  $rdr$ , for various inflation rates, for the base case, historical and country-specific alternative

scenarios (see Figure 4). The rdr, estimated for the base line scenario assumes that large primary surplus as of 2005 is to be maintained indefinitely at 6.5 percent of GDP and that the real growth rate will remain strong – at 5 percent per year on average.

Large primary balances and strong growth rate creates substantial headroom in terms of seigniorage and debt carrying capacity given stable debt-output targets. At macro data like this, the model indicates an over adjustment of over 5 percent of GDP, an overshooting policy that seems wise given the continuing external credibility problems (external current account deficits are widening and the spread, although much reduced, remains high). In fact, the consistency analysis also shows there is some leeway; the interest rates can go up substantially without inconsistency between fiscal policy and monetary targets becoming a real threat.

*Figure 4. Required deficit reduction for various inflation rates*



However, vulnerability factors remain. First, there is a concern that the quality and the durability of the fiscal adjustment may not be sustainable. In particular, while the overall primary fiscal surplus is impressive by international standards, substantial pension deficits (in the order of 5 percent of GDP) crowd out the rest of public expenditure and make it harder for Turkey to sustain this primary surplus in the future. Pension reform may be necessary to allay this fear. In particular, the model indicates that setting all key variables to their historical averages will more than halve the headroom to about 2 percent at the targeted inflation rate of 3.5 percent. This scenario shows that the rdr measure is very sensitive to even a small shortfall of the projected primary surplus (6 percent of GDP, as compared to 6.5 percent in the base case) and a lower growth rate (an annual

average of 4 percent as opposed to 5 percent long run growth rate in the base case).<sup>17</sup> Second, despite all the recent achievements and commitments to further reforms, Turkey is vulnerable to changes in market sentiments as the external public debt has still large roll-over requirements and it has a very short maturity structure. Third, even if the public sector has its house in order, the recent emergence of large private sector dissaving, with an associated substantial widening of the Turkish current account deficit may trigger expectations of exchange rate depreciation. Such depreciation, with the associated capital losses on external public debt, would once again threaten fiscal sustainability, and may bring back instability concerns in the context of inflation targeting.

To demonstrate the sensitivity of the *rd*, our consistency measure, we compare the base case *rd* with the *rd* implied by the country-specific alternative scenario. This scenario assumes much weaker fiscal efforts, which triggers a loss of confidence by foreign investors and a sudden stop in the availability of foreign financing in 2006. As a consequence, substantial real depreciation in 2006 and 2007, sharp increases in domestic and external real interest rates, and as a result much lower growth performance (see table 5, section 3.3). Under these assumptions, the model indicates a required additional fiscal adjustment of about 10 percent of GDP to restore consistency with the targeted inflation rate of 3.5 percent!! As shown in Figure 4, this massive required deficit reduction is reduced significantly only at triple digit inflation rates.

### 3.5. *The stochastic simulations approach*

To account for the high volatility of key variables, such as real interest rates, real growth rates and changes in the real exchange rate, and to assess the impact of uncertainty on fiscal sustainability, we use stochastic simulations (see section 2.4 of this paper, IMF(2003) and Celasun, Debrun and Ostry (2005)). This approach to incorporating uncertainty into sustainability analysis allows for interactions among the underlying debt dynamics factors (e.g. GDP growth rate, interest rate, inflation rate, exchange rate, etc.) by estimating a vector autoregressive model (VAR) on historical data. The estimated VAR model can then be used to generate a “Fan chart” of debt-to-GDP ratios using Monte Carlo simulations. Such a probabilistic approach to fiscal sustainability depicts the magnitude of risks – upside and downside – surrounding public debt projections as a

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<sup>17</sup> See table 4, section 3.3, which lists key assumptions of the historical scenario.

result of external and/or policy shocks. In addition, this approach can be used to show the distribution of the measure of required deficit reduction.

In general this approach is implemented by first estimating a VAR model for the foreign real interest rate  $r^f$ , the domestic real interest rate  $r^d$ , the real GDP growth rate  $g$ , and depreciation of the real exchange rate  $e$ , i.e.,  $V_t = (r_t^f, r_t^d, g_t, e_t)$ .

As an illustration, the following regression results for Turkey are obtained from an unrestricted 4-variable VAR model on quarterly data for the period 1990.Q1 – 2004.Q4. The lag order for the Turkey VAR estimation is chosen to be 1.<sup>18</sup> Given this order selection, the augmented Dickey-Fuller tests on the underlying variables reject the hypotheses that there are unit roots at 5% significance level. A regular VAR specification is therefore implemented.

*Table 5. Turkey: VAR coefficients*

	Depreciation of RER	Domestic interest rate	Foreign interest rate	Growth rate
Depreciation of RER (-1)	0.6164132*** [0.1214663]	-0.0764374 [0.0745745]	0.0071392*** [0.0032883]	-0.0163632 [0.0578173]
Domestic interest rate(-1)	0.5183742** [0.1300432]	0.7703966*** [0.0798403]	-0.0034098 [0.0035205]	0.2292575*** [0.0618999]
Foreign interest rate (-1)	2.613194** [1.310771]	0.1130593 [0.8047509]	0.9929505*** [0.0354851]	0.8727535 [0.6239205]
Growth rate (-1)	.0078362 [0.2706376]	-0.0719824 [0.1661585]	-0.0050722 [0.0073267]	0.6440931*** [0.1288221]
Constant	-17.6484** [6.057141]	3.862517 [3.718795]	0.0658478 [0.1639787]	-5.609101* [2.883169]

Note: Standard errors in brackets. \* indicates significance at 10%, \*\* at 5%, and \*\*\* at 1%.

Table 5 reports the coefficients from the VAR estimation. The lag order for the Turkey VAR estimation is chosen to be 1 both because more lags would require a longer time series and because SBIC statistics indicate that 1 lag is the most appropriate choice for the current sample. Given this order selection, the augmented Dickey-Fuller tests on the underlying variables reject the hypotheses that there are unit roots at 5% significance level. A regular VAR specification is therefore implemented. Table 5 reports the coefficients from the VAR estimation.

<sup>18</sup> See Annex 1 for further details on the VAR estimation for Turkey.

The corresponding estimated variance-covariance matrix  $\hat{\Sigma}$  is reported in Table 6. The estimated variance-covariance matrix  $\hat{\Sigma}$  of the vector of four debt determinants is then used to generate a sequence of 4-element random vectors using Monte Carlo simulations.

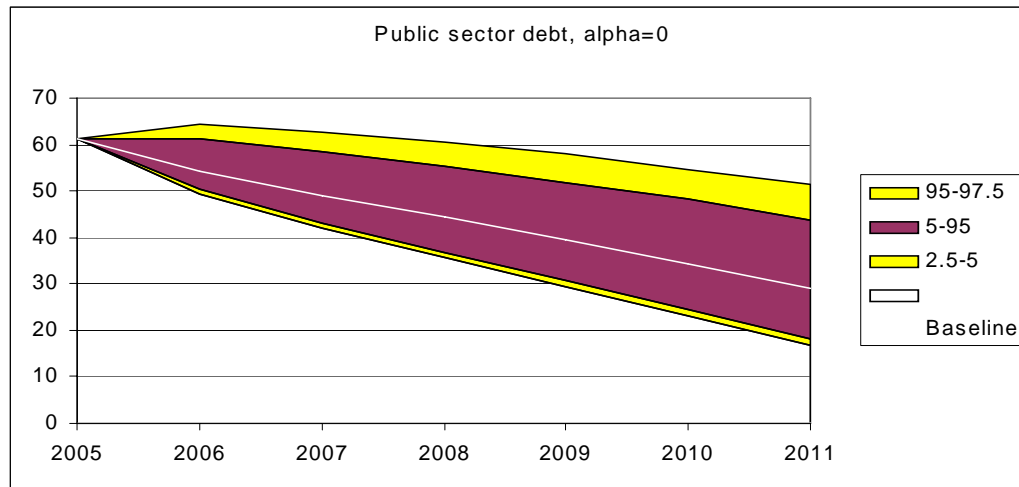
*Table 6. Estimated Variance-Covariance Matrix ( $\hat{\Sigma}$ )*

	Depreciation of RER	Domestic interest rate	Foreign interest rate	Growth rate
Depreciation of RER	81.1591	-6.30625	-0.165489	23.1178
Domestic interest rate	-6.30625	30.5919	-0.164606	7.36655
Foreign interest rate	-0.165489	-0.164606	0.059481	0.112955
Growth rate	23.1178	7.36655	0.112955	18.3883

Based on the estimated variance-covariance matrix, the tool uses a programming algorithm that computes the resulting debt dynamics by feeding each vector of stochastic realizations in the debt updating equation. The FS tool then simulates this dynamic debt process as many times as desirable (5000 times by default). Finally, the tool plots the probability density of the outcomes of debt ratio from the stochastic simulations, generating a “Fan chart” for debt-to-GDP ratio as in Celasun, Debrun and Ostry (2005). The “fan-chart” for public debt-to-GDP ratio, using as an input the variance-covariance matrix of the estimated VAR process is graphed in Figure 5. As this figure indicates, indicates, there is a 50 percent chance that public debt will be below 29 percent of GDP at the end of the projection period; there is also 95 percent chance that public debt will be below about 50 percent at the end of the projection period.

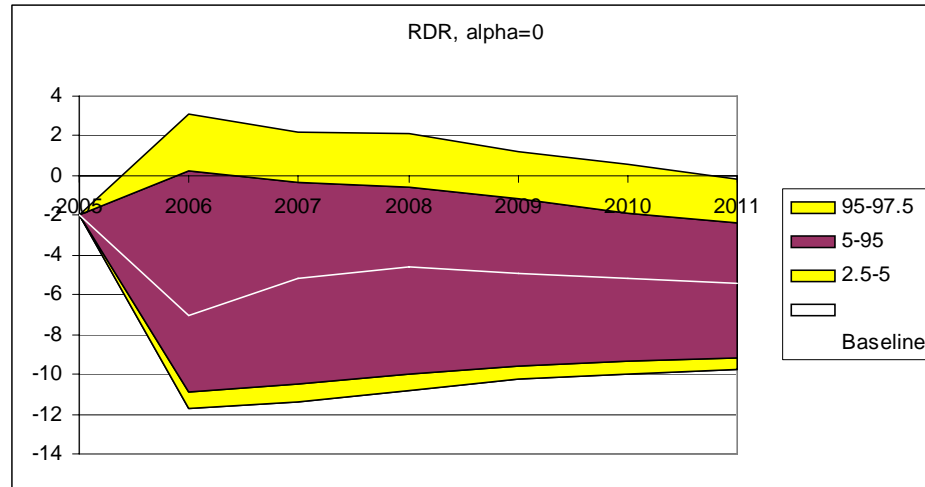
The simulated probability distribution for public debt ratio could also be used to compare the results from various stress tests for public debt ratio with for example the 95 percent critical value of debt-to-GDP ratio from the simulated probability distribution, which will give an indication about the likelihood of the stress tests, discussed in section 3.2. While scenarios like the country specific shock, A3, appear to result in unrealistically high debt-to-GDP ratio it is important to stress that all these stochastic simulations assume that government will be able to sustain primary surpluses of 6.5 percent of GDP throughout the projection period on average. However, any fiscal loosening will likely result in a much higher debt-to-GDP ratios in the end of the projection period.

*Figure 5 Stochastic Simulations for Net Public Debt to GDP ratio in percent.*



Finally, this approach could also be used to show the probability distribution of the required deficit reduction – a measure that calculates the additional fiscal effort needed to stabilize public debt to GDP ratio in any given year throughout the projection period, as a result of random shocks to key debt determinants. As the results in Figure 6 indicate, if Turkey is to maintain its sizeable primary surplus of 6.5 percent of GNP, as in the base case, there is 97.5 percent probability that fiscal policy will be at least consistent with stable debt ratios and targeted inflation rate in 2006 and there is only 2.5 percent probability that additional fiscal adjustment maybe needed in 2001 to ensure consistency with inflation target in 2001 and to stabilize the debt to GNP ratio at its 2011 level. Now note again, that these results are once again underpinned by the aggressive fiscal adjustment strategy. However, vulnerabilities remain to the extent that the quality and durability of the fiscal adjustment may not be sustainable.

Figure 6. Required Deficit Reduction as a percent of GDP



### 3.6. Fiscal Policy Response to Shocks

Bohn (1998) shows that governments concerned with fiscal sustainability should raise the primary surplus in response to increasing public debt ratios. If all other determinants of fiscal policy are stationary, a positive correlation between the primary surplus and the past level of the public debt ratio is sufficient to stabilize the public debt to GDP ratio, or, in other words, to guarantee fiscal sustainability.

Celasun, Debrun and Ostry (2005) have estimated a fiscal policy reaction function for a panel of emerging market countries, whereby primary balance is modeled as a response function of previous period debt stock, business cycles, and random shocks. Data permitting, such a fiscal policy reaction function could be estimated for the concrete country – in this case Turkey.<sup>19</sup>

The fiscal sustainability tool provides fiscal policy reaction function as an additional option available for all the stress tests and stochastic simulations. Specifically, the user can supply a value for alpha, which determines the debt feedback rule. Note that any positive value of alpha would imply that fiscal surplus is reacting to past level of debt. One plausible assumption is that this coefficient is set between zero – no fiscal reaction and the real rate of interest on public debt. In this way, the user can check the sensitivity of projected debt dynamics to various coefficients of correlation between the primary balance and past debt-to-GDP ratio. In principle, the panel data

<sup>19</sup> See also Appendix 2 two for Turkey specific estimations.

estimations could be used to derive either country specific estimates, or to use the average for the panel. It maybe also useful to check the sensitivity of stochastic simulations to various values for alpha, the fiscal policy reaction coefficient – high values of alpha maybe good for sustainability, but may imply excessive surpluses, for example.

Next, we compare our results, using the default value of alpha of 0.02 and the estimated Turkey specific coefficient – 0.22. The results of the various runs are shown in Figures 7a, 7b, 8a and 8b. As expected, the higher the value of alpha, the narrower the confidence interval is (See Figure 7a and 7b). Similarly, our measure of required deficit reduction would also be sensitive to the value of alpha. The higher the value of alpha, the narrower the fan-chart is for the rdr measure. There is 95 percent probability that Turkey will have additional headroom, larger than 2 percent of GNP at the end of the projection period (see Figure 8b).

*Figure 7. “Fan chart” for Public Debt-to-GNP ratio with a. alpha=0.02 and b. alpha=0.22*

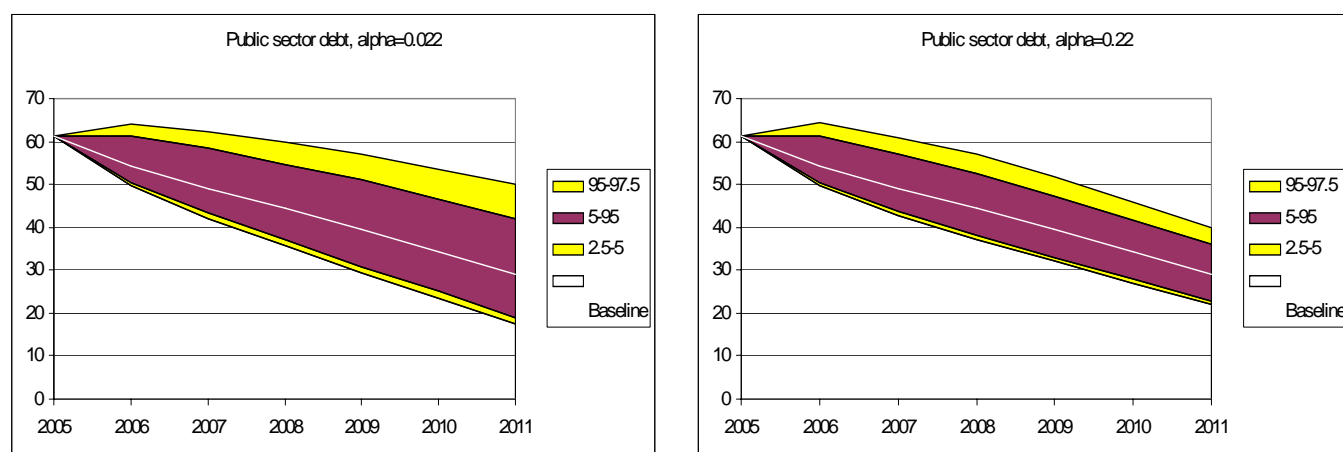
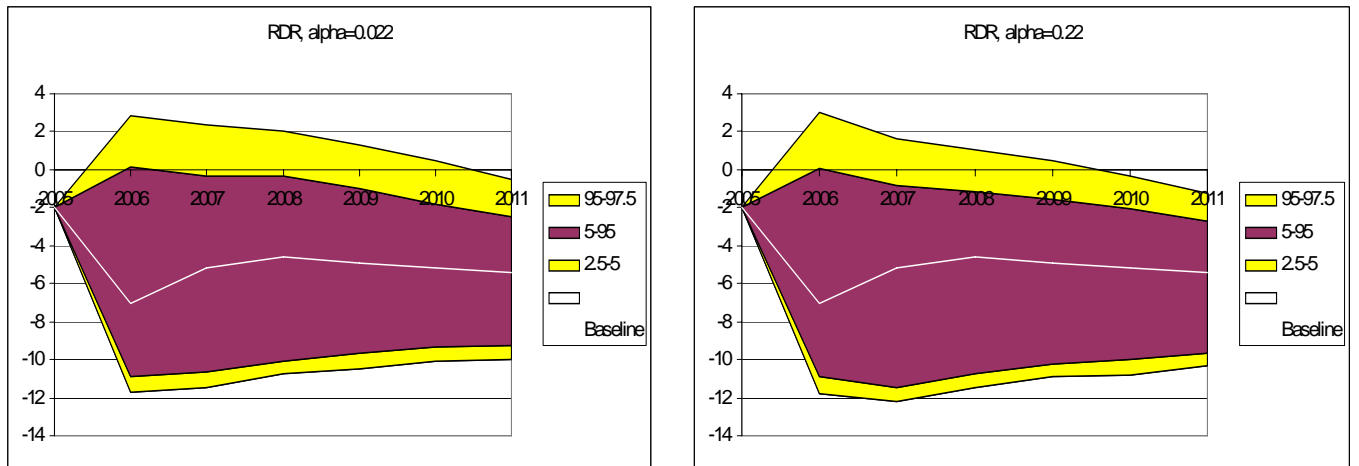




Figure 8 “Fan chart” for RDR a.  $\alpha=0.02$  and b.  $\alpha=0.22$



#### **4      *Conclusions***

This paper presents the analytical framework that underpins the fiscal sustainability tool and applies this tool to the case of Turkey. While Turkey is an interesting example on its own right, many issues that are familiar from other countries show up here too, making the case of wider interest.

Despite its long history of high and volatile inflation, Turkey has succeeded in bringing about a dramatic reduction in inflation since 2001. Similarly, following the devastating 2001 financial crisis, public debt ratio has been declining rapidly reaching 61.2 percent of GNP by end-2005, compared with 89.5 percent in 2001. Public debt composition has also improved significantly, with the share of foreign currency denominated debt falling from 40 to 28 percent of total public debt during 2001-2005.

Is the current situation, with inflation at single digit level for the first time since decades sustainable? Can Turkey grow out of its debt problem, lowering further its debt burden to more manageable levels and is Turkey still vulnerable to sudden reversal of capital inflows?

To answer these questions, this paper applied the fiscal sustainability tool for the case of Turkey. The application of the FSA tool involved: (i) using public debt dynamics to create a baseline projection of future trends in public debt to GDP ratio, utilizing existing macroeconomic projections; (ii), conducting sensitivity tests to the baseline scenario; (iii) applying a simplified version of the steady state consistency framework of AW (1989) to assess the consistency of the fiscal strategy with the targeted inflation rate, stable debt ratios, and with other structural characteristics of the economy and checking the sensitivity of the consistency indicator, the  $rdr$ ; (iv), using stochastic simulations to depict the magnitude of risks – upside and downside – surrounding public debt projections and the consistency measure; and (v) checking the sensitivity of public debt and  $rdr$  distributions to several parameters for fiscal policy reaction functions.

The results suggest that if continued, the size and duration of the recent fiscal adjustment has been such that it will trigger a rapid decline in public debt (as a share of GDP) over the projection period. The issue of inconsistency between fiscal policy and inflation targets, given stable debt ratios at the end of the projection period, can be safely set aside. The proviso about sustaining the fiscal adjustment may be a serious one however, possibly explaining the stubbornly

high premium Turkey still (in 2006) has to pay in external capital markets. Moreover, the consistency analysis shows that there is some leeway: interest rates can go up substantially without inconsistency between fiscal policy and monetary targets becoming real treats.

However, while inflation targeting seems to be consistent with the strong fiscal stance adopted recently and with the rapidly declining public debt ratio, risks to fiscal sustainability remain. First, there is a concern that the quality and the durability of the fiscal adjustment may not be sustainable. In particular, while the overall primary surplus is impressive by international standards, substantial pension deficits (in the order of 5 percent of GDP) crowd out the rest of public expenditure and make it harder for Turkey to sustain this primary surplus in the future. Pension reform may be necessary to allay this fear.

Second, while the level of the primary surplus is remarkable and indeed the interest burden declining accordingly, Turkey's fiscal position is still precarious, given the still large roll-over requirements of Turkey's public (external) debt and its very short maturity structure.

Third, even if the public sector has its house in order, the recent emergence of large private sector dissaving, with an associated substantial widening of the Turkish current account deficit may trigger expectations of exchange rate depreciation. Such depreciation, with the associated capital losses on external public debt, would once again threaten fiscal sustainability, as demonstrated in the country-specific alternative scenario, which evaluates fiscal sustainability in the case of faltering fiscal reforms and resulting sudden stop, triggered by loss of confidence of foreign investors. To this end, while such a scenario seems highly improbable, the probability of this scenario may increase significantly, contingent on future fiscal relaxation.

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## Appendix 1 Estimation of a VAR system for key debt determinants for Turkey

To account for high volatility of key endogenous variables, such as real interest rates, real growth rates and changes in the real exchange rate, and to assess the impact of uncertainty on fiscal sustainability, we use stochastic simulations approach as in IMF(2003) and in Celasun, Debrun and Ostry (2005). In general this approach is implemented by first estimating a VAR model for key debt determinants: ex-post real foreign interest rate,  $r^f$ , real domestic interest rate,  $r^d$ , real GDP growth rate,  $g$ , and depreciation of the real exchange rate,  $e$ , i.e.,

$$V_t = (r_t^f, r_t^d, g_t, e_t).$$

To estimate a VAR model, we have used the following time series for the period 1990q1-2004q4: real effective exchange rate (reer), real GDP growth (gdpr) and real domestic interest rates (rdom) which come from WDI. For foreign interest rate we use US interest rate on treasury (rtreas).

We next check for unit roots of individual time series to make sure that they are stationary. We thus perform augmented Dickey-Fuller test on each of the series. We reject unit root at the 5% level for all series, and we reject unit root at the 1% level for all series when we include time trend.

**Table A.1 Turkey: Unit Root Tests, Quarterly data, 1990q1 – 2004q4**

Variable from VAR	With intercept only	With intercept and trend
dlog(reer)	-6.591***	-6.555***
dlog(gdp_r)	-8.227***	8.167***
Rdom	-8.821***	-9.212***
Rtreas	-3.198**	-5.558***

\*: reject unit root at 10% level

\*\*: reject unit root at 5% level

\*\*\*: reject unit root at 1% level

Since our tool performs stochastic simulations based on annual data for public debt updating equation, we had to annualize these variables before estimating a VAR model. To estimate the VAR model, we also need to choose the appropriate lag structure, which is done based on variety of information criteria such as the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC). In addition, STATA also reports likelihood-ratio test statistics (LR) and log-likelihood test statistics (LL). Given the relatively short time period, we have estimated a VAR system with just 1 lag, which is the lag selected by the SBIC criteria (STATA typically puts most emphasis on SBIC criterion).

**Table A.2. The choice of the appropriate lag structure.**

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-603.979		265887	23.8423	23.9002	23.9938
1	-469.189	269.58	2527.29	19.1839	19.4734	19.9415*
2	-452.825	32.728	2522.56	19.1696	19.6907	20.5332
3	-438.473	28.703	2775.84	19.2342	19.9869	21.204
4	-414.186	48.575	2129.53	18.9092	19.8935	21.485

The table below shows the estimated coefficients of the VAR model. However, to avoid spurious regressions, it is also necessary to check if these variables are co integrated. Since all the variables are stationary (see Table A.1), this is already an evidence that cointegrating relationship exists. However, we also perform the Johansen's procedure to test for cointegrating relationship between the variables included in the VAR model (see Table A.4).

**Table A.3. Estimated VAR Model for Turkey for the period**

	Depreciation of RER	Domestic interest rate	Foreign interest rate	Growth rate
Depreciation of RER (-1)	0.6164132*** [0.1214663]	-0.0764374 [0.0745745]	-0.0071392*** [0.0032883]	-0.0163632 [0.0578173]
Domestic interest rate(-1)	0.5183742** [0.1300432]	0.7703966*** [0.0798403]	-0.0034098 [0.0035205]	0.2292575*** [0.0618999]
Foreign interest rate (-1)	2.613194** [1.310771]	0.1130593 [0.8047509]	0.9929505*** [0.0354851]	0.8727535 [0.6239205]
Growth rate (-1)	.0078362 [0.2706376]	-0.0719824 [0.1661585]	-0.0050722 [0.0073267]	0.6440931*** [0.1288221]
Constant	-17.6484** [6.057141]	3.862517 [3.718795]	0.0658478 [0.1639787]	-5.609101* [2.883169]

Note: Standard errors in brackets. \* indicates significance at 10%, \*\* at 5%, and \*\*\* at 1%.

Based on the estimated VAR model, Stata reports the variance-covariance matrix of the errors, which is then used to perform stochastic simulations option of the FS tool.

**Table A.4 Estimated Variance-Covariance Matrix ( $\hat{\Sigma}$ )**

	Depreciation of RER	Domestic interest rate	Foreign interest rate	Growth rate
Depreciation of RER	81.1591	-6.30625	-0.165489	23.1178
Domestic interest rate	-6.30625	30.5919	-0.164606	7.36655
Foreign interest rate	-0.165489	-0.164606	0.059481	0.112955
Growth rate	23.1178	7.36655	0.112955	18.3883

## Appendix 2 Estimating Fiscal Reaction Function

The FSA template allows us to include a fiscal policy reaction function. In general, fiscal policy would react to past level of debt as the government would typically adjust its primary balance in response to shocks. Specifically, primary balance can be modeled as a response function of debt stock, business cycles, and random shocks. That is, primary balance is stochastic, with an extra debt-stabilizing effort.

$$pb_t = c + \alpha d_{t-1} + \phi z_t + \varepsilon_t \quad (\text{A.1})$$

where  $i$  indicates country,  $t$  year,  $pb$  primary balance (as % of GDP),  $d$  public debt (as % of GDP),  $z$  the percentage deviation of output from its HP-filtered trend, which serves to reflect transitory macroeconomic shocks to expenditure and revenue during business cycles.

In the specification above, the level of response from the government is guided by a parameter  $\alpha$ . The higher the  $\alpha$ , the stronger the fiscal policy response.  $\alpha$  parameter can be estimated from the data.

A natural way to gauge a government's fiscal policy reaction is to estimate it by virtue of historical data. Celasun, Debrun and Ostry (2005) estimate fiscal reaction function using panel data for 34 emerging market countries for the period 1990-2004. However, panel data estimates on fiscal reaction may fail to fully capture the country-specific policy situations, despite the inclusion of the "fixed effect" for countries. For instance, Turkey's primary balances may behave differently from the panel average.

In what follows we have estimated a Turkey-specific fiscal policy reaction function, using annual data for consolidated primary balance as a share of GDP, public debt-to-GDP ratio, real GDP growth for the period 1990-2005 (see table 1 for data description and sources).

**Table 1. Data descriptions and sources for Turkey. Annual (1990-2005)**

Variable	Description	Source
Primary surplus (% of GDP)	The most comprehensive coverage of the fiscal sector available	IMF desk and fiscal economists
public debt (% of GDP)	Same as above	Same as above
Output gap (%)	percent deviation of real GDP from its Hodrick-Prescott filtered real GDP /trend/	IMF International Financial Statistics or World Economic Outlook
Real GDP	real gross domestic product in billions of domestic currency	IMF World Economic Outlook

The estimated fiscal policy reaction function for Turkey is shown in table 2. We can see that the coefficient on lagged debt  $\alpha$  is highly significant and as results suggest there is a very high primary surplus response to increases in public debt. Two explanatory variables are found very significant at 1% level: the coefficient of lagged debt and the constant term. It is worth highlighting that the magnitudes of both coefficients are considerably larger than those estimated from the panel GMM.<sup>20</sup> We then use our estimate for  $\alpha$  as the parameter for the fiscal policy reaction function option, implemented in the FS tool.

**Table 2. OLS estimate of fiscal reaction on Turkey only (1990-2005)**

<sup>20</sup> The preferred specification of the panel data estimates suggest that fiscal policy reaction coefficient,  $\alpha$ , is much smaller on average for the 34 emerging market countries (0.046), as compared with the coefficient on lagged debt ratio for Turkey (0.22). For such a comparison, see Celasun, Debrun and Ostry (2005), pp. 17.



Dependent variable: primary balance

	Coefficient	t-statistic
Lagged Debt	0.227***	4.94
Output Gap	-0.005	-0.02
Dummy (for 2001)	3.247	0.85
Constant	-10.837***	-4.34
Number of obs.	15	
F( 3, 11)	8.95	
Prob > F	0.003	
R-squared	0.710	
Adj R-squared	0.630	
Durbin-Watson d-statistic	1.392	

Note: \*\*\* denotes significance at 1%. The dummy equals 1 for the crisis year 2001

Nina Budina  
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